AFCRL 62-226

GRD RESEARCH NOTES
No. 74

RELATIONSHIPS BETWEEN H-ALPHA LINE WIDTH, INTENSITY, AND FLARE AREA

Elske v. P. Smith

January 1962

GEOPHYSICS RESEARCH DIRECTORATE
AIR FORCE CAMBRIDGE RESEARCH LABORATORIES
OFFICE OF AEROSPACE RESEARCH
UNITED STATES AIR FORCE
BEDFORD, MASSACHUSETTS

"GRD Research Notes are published as a medium for disseminating, in a relatively rapid and informal way, significant research results obtained in the course of a broader investigation, or interim information pending completion of a major research effort."

Requests for additional copies by Agencies of the Department of Defense, their contractors, and other government agencies should be directed to the:

Armed Services Technical Information Agency
Arlington Hall Station
Arlington 12, Virginia

Department of Defense contractors must be established for ASTIA services, or have their 'need-to-know' certified by the cognizant military agency of their project or contract.

All other persons and organizations should apply to the:

U. S. DEPARTMENT OF COMMERCE
OFFICE OF TECHNICAL SERVICES,
WASHINGTON 25, D. C.

AFCRL-62-226

GRD Research Notes
No. 74

RELATIONSHIPS BETWEEN H-ALPHA LINE WIDTH, INTENSITY AND FLARE AREA

Elske v. P. Smith

January 1962

Project 7649
Task 76490

Contract No. 19(604)-4961
with
Harvard College Observatory

Sacramento Peak Observatory
GEOPHYSICS RESEARCH DIRECTORATE
AF CAMBRIDGE RESEARCH LABORATORIES
OFFICE OF AEROSPACE RESEARCH
UNITED STATES AIR FORCE
Bedford, Massachusetts

ABSTRACT

The relationship between several parameters of the H-alpha line at or near maximum is studied. These parameters are line width, central intensity, and flare area. The data were obtained from the I. A. U. Quarterly Bulletin. The correlations between any two of the three characteristics are quite loose, with large amounts of scatter as shown in the appended figures.

RELATIONSHIPS BETWEEN H-ALPHA LINE WIDTH, INTENSITY AND FLARE AREA

Ellison (1949, 1952) found that the H-alpha line-width in flares is correlated with the central intensity. His results were based on a homogeneous sample of data obtained with his spectrohelioscope-spectrograph combinations at Sherborne and Edinburgh. The relationship was linear up to an intensity of about 150 percent of the continuum, but beyond that point the width increased more rapidly with respect to the intensity. In his analysis of the flare of August 5, 1949, Svestka (1951) too found that H-alpha line profiles with large widths tend to have relatively small central intensities. Line widths determined photographically considerably exceeded visual estimates, hence the slope of the relationship between width and intensity depended upon the method of observation. The number of observations used in delineating Ellison's relationship was necessarily limited. For this reason we have used data reported in the IAU Quarterly Bulletin to ascertain whether one may formulate a unique relationship between the H-alpha line-width and central intensity.

Figures 1 a-e are the graphs of the maximum H-alpha width plotted against the central intensity in terms of the neighbouring continuum. Data from each observatory are handled separately to avoid differences due to instrumentation and techniques of reduction. Even with this precaution, the graphs show a large amount of scatter. The correlation is best shown on the plots obtained with data from Herstmonceux and Tashkent. We conclude that though width and intensity both tend to increase together, a strict relationship between the two parameters does not exist. The H-alpha line may be quite intense in some flares while yet having a relatively narrow profile. Similarly many flares have a wide H-alpha line without being very bright. In short, there is considerable variation from flare to flare.

One of the disadvantages in using data from the Quarterly Bulletin lies in the fact that there is no certainty that the data thus reported refer to the time of flare maximum. In a few cases it is possible to study the relationship between intensity and width during the course of the lifetime of a flare. From such studies it is then possible to gauge how much of the scatter in Figures 1 a-e may be attributed to the fact that the observations were not all made at the time of flare maximum. Figures 2 a-d show the relationship of width to intensity for several individual flares. Two of these were observed at Sacramento Peak, while data for the others were taken from papers by Svestka (1961) and by Ellison (1952). Note that both the intensity and wavelength scale differ for different flares to accommodate their respective ranges. These graphs indicate a considerable amount of scatter even for individual flares, though the variation from flare to flare is still much larger. The points plotted in Figures 2 a-d include measurements throughout the flare lifetimes; the sample is too small to determine whether the relationship would be improved by including only premaximum and maximum data. Ellison (1952) has shown from his development curves of central intensity and line width that the width decreases more rapidly after maximum than the intensity. The generally smaller widths for the post-maximum points of the September 2, 1960 flare tend to corroborate this conclusion.

That flare area, hence importance, is correlated with the H-alpha central intensity at time of maximum has long been known. Ellison (1952) for instance tabulates the average intensity for each importance classification. Dodson et al (1956) too have shown the relationship graphically on the basis of McMath-Hulbert data. Figures 3 a-e are again based on data reported in the Quarterly Bulletin. The scatter is so large in these graphs that one might almost doubt the reality of a relationship between area and intensity. In fact the mean points, indicated by x's on the graphs, show that the intensity increases only very slightly with increasing area. These mean points represent the mean of the intensity and area over a given area interval. Very few subflares are included in the Quarterly Bulletin, and their exclusion in Figures 3 a-e may well account for the apparent lack of a clear relationship. Miss Dodson's graph did include subflares (area <2 square degrees) and even plage brightenings; the inclusion of these smaller phenomena greatly affect the appearance of the graph. The significance of subflares in an area-intensity relationship is also apparent from Sacramento Peak data (H. J. Smith 1962).

A similarly large scatter appears in the area-width relationship shown in Figures 4 a-f. This is hardly surprising in view of the loose correlation between area and intensity, and between width and intensity.

We may conclude, therefore, that although flares of large area (and hence great importance) are more likely to have H-alpha profiles with high central intensities and large widths than flares of small areas, nevertheless the three parameters are not closely interrelated.

The data from the Quarterly Bulletins used for this Note were extracted and plotted by Charles Fox, to whom I wish to make grateful acknowledgement. My thanks also go to Mrs. Margaret Smith for preparing the graphs reproduced here.

REFERENCES

1. Dodson, H. W., Hedeman, E. R. and McMath, R. R., Ap. J. Supp. II, 241, No. 20, 1956.

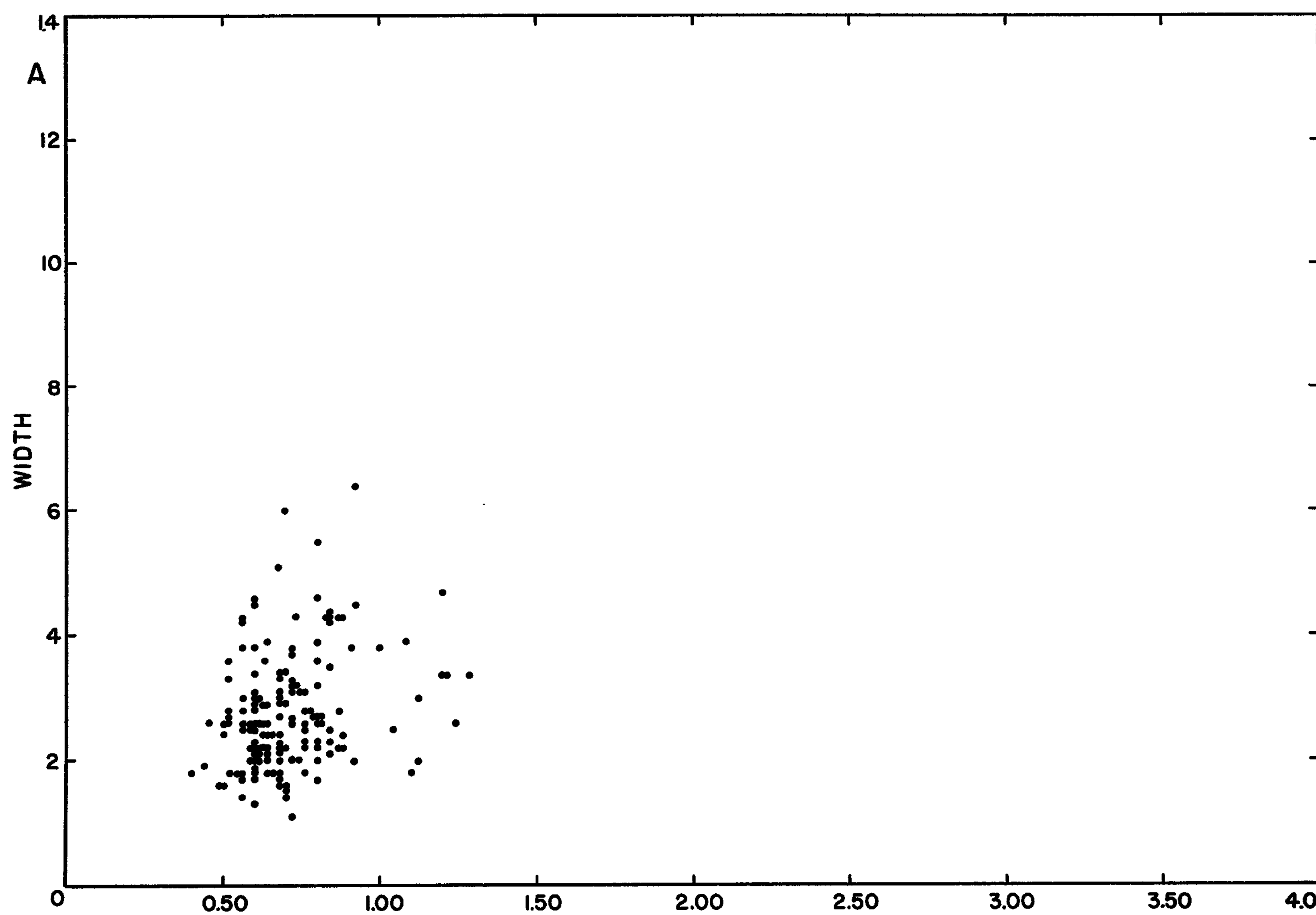
2. Ellison, M. A., Monthly Notices R. A. S., 109, 3, 1949.

3. Ellison, M. A., Publ. Royal Obs. Edinburgh, 1, No. 5, 1952.

4. Smith, H. J., GRD Research Note, in press, 1962.

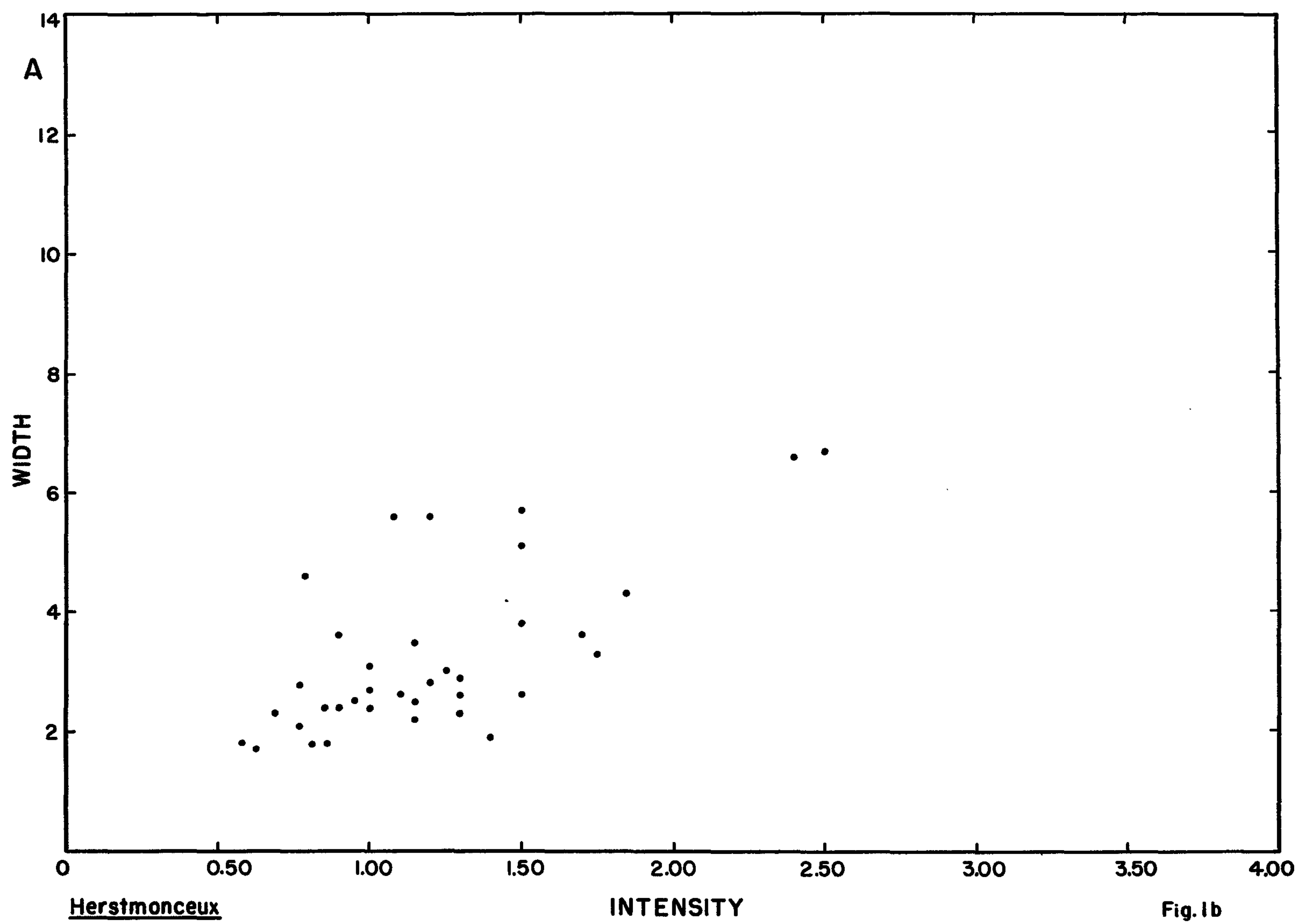
5. Svestka, Z., Bull. Ast. Int. Czechoslovakia, 2, 165, 1951.

6. Svestka, Z., Bull. Ast. Int. Czechoslovakia, 12, 73, 1961.



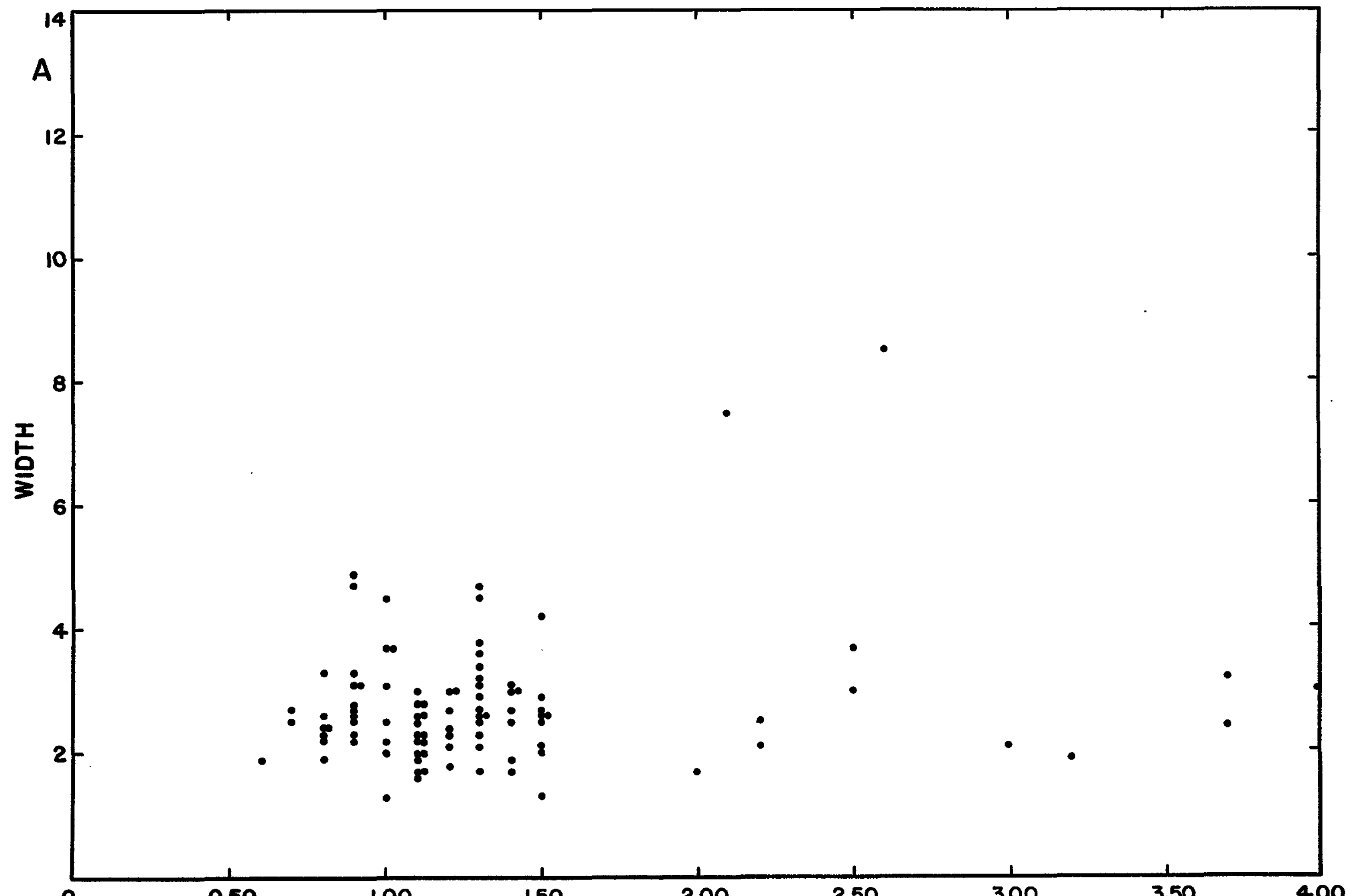
<u>Crimea</u>

Fig. 1a



Herstmonceux

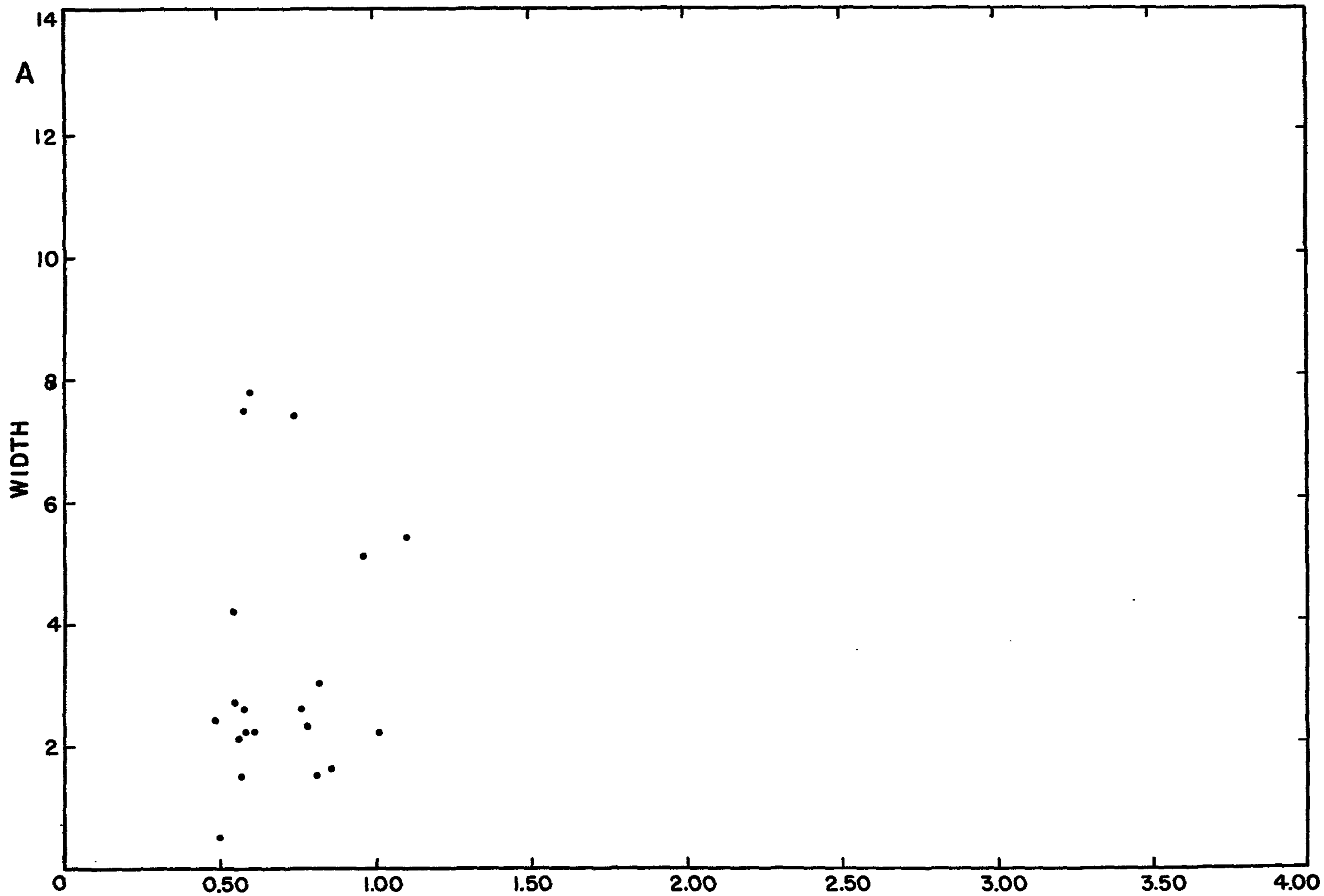
Fig. 1b



Moscow

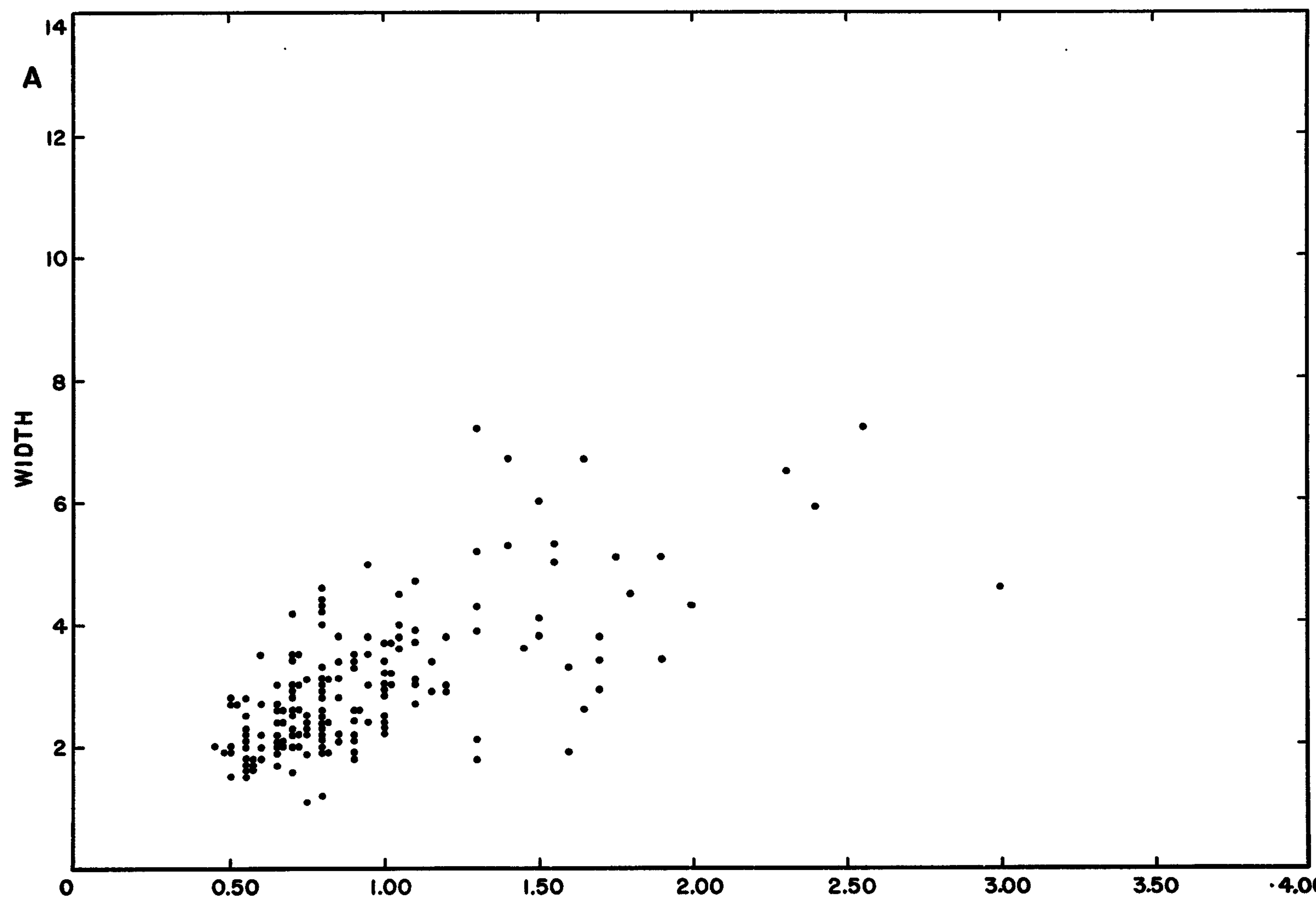
INTENSITY

Fig. Ic



Nismir

Fig. 1d



Tachkent

Fig. 1e

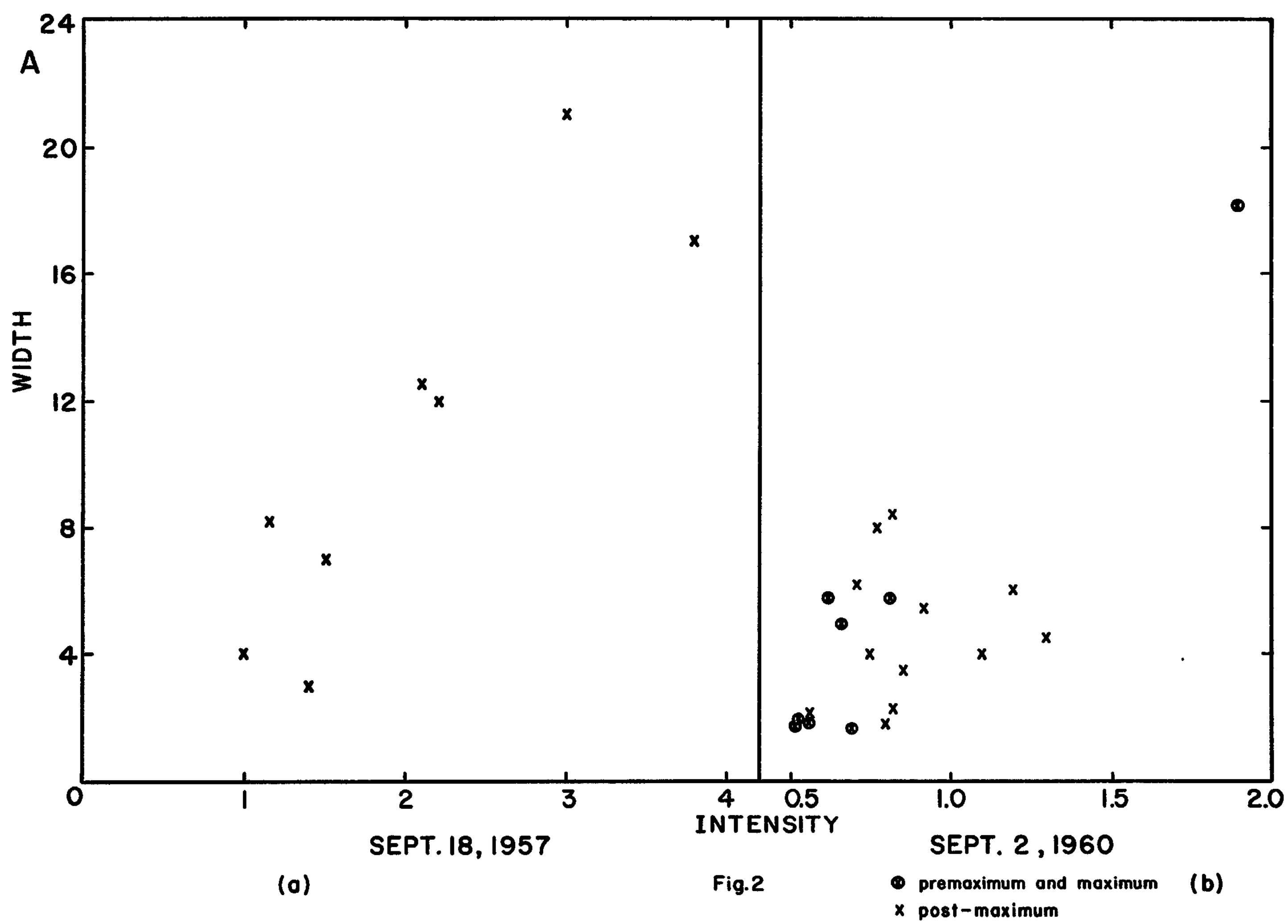
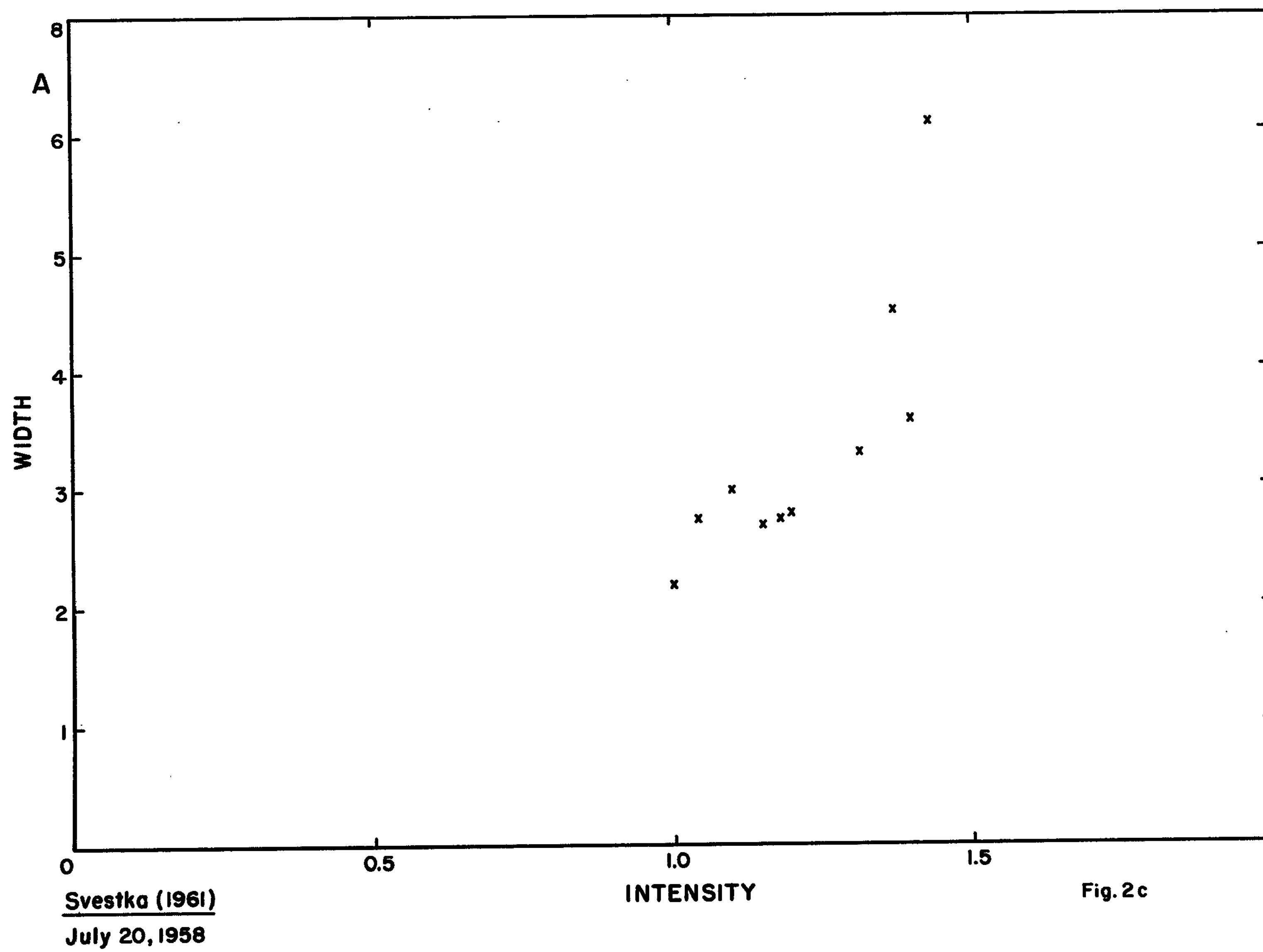
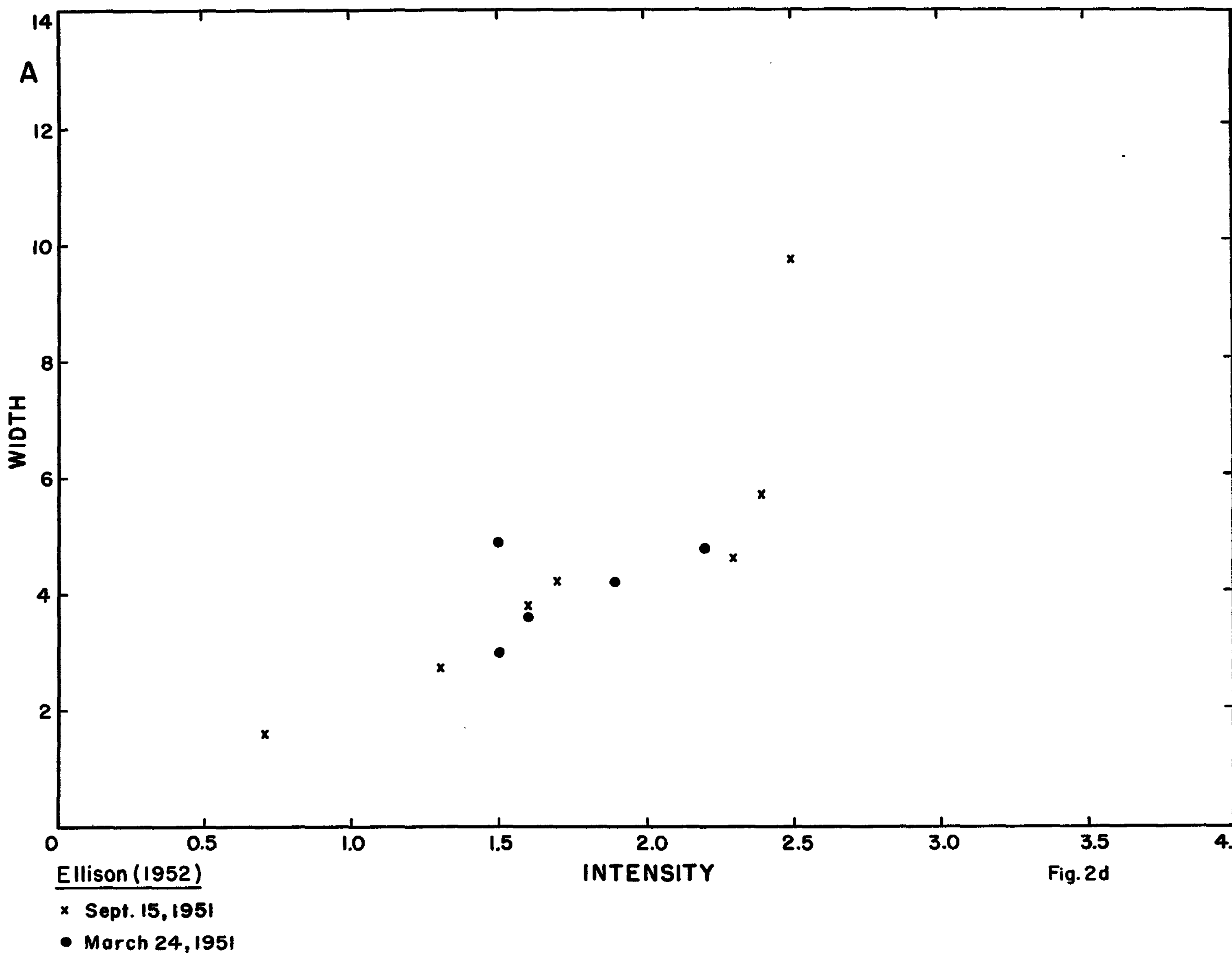

A
WIDTH
24
20
16
12
8
4
0
1
2
3
4
0.5
1.0
1.5
2.0
INTENSITY
SEPT. 18, 1957
SEPT. 2, 1960
(a)
⊗ premaximum and maximum
x post-maximum
(b)

Fig. 2



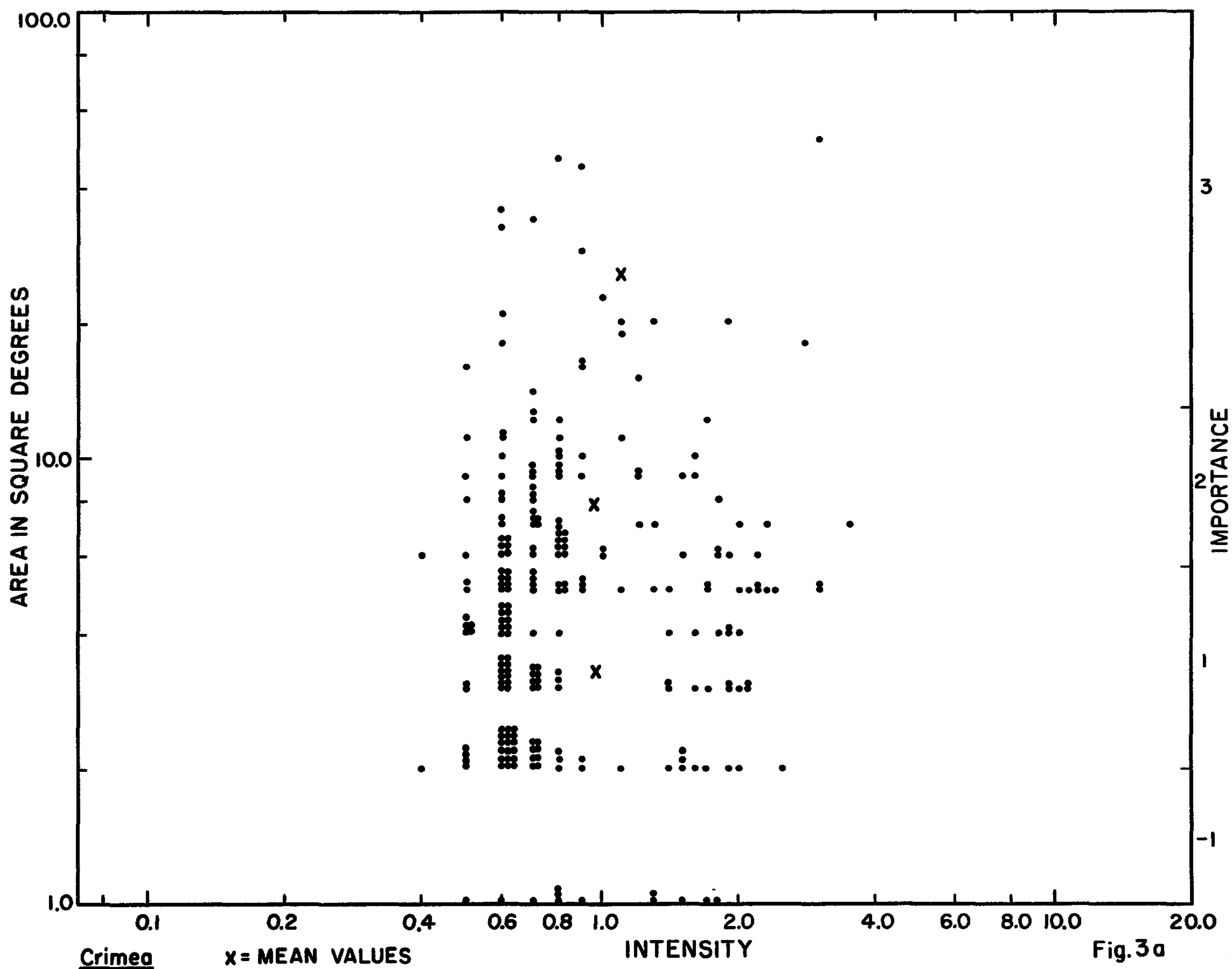
A
WIDTH
8
6
5
4
3
2
1
0
0.5
1.0
1.5
INTENSITY
Svestka (1961)
July 20, 1958

Fig. 2c



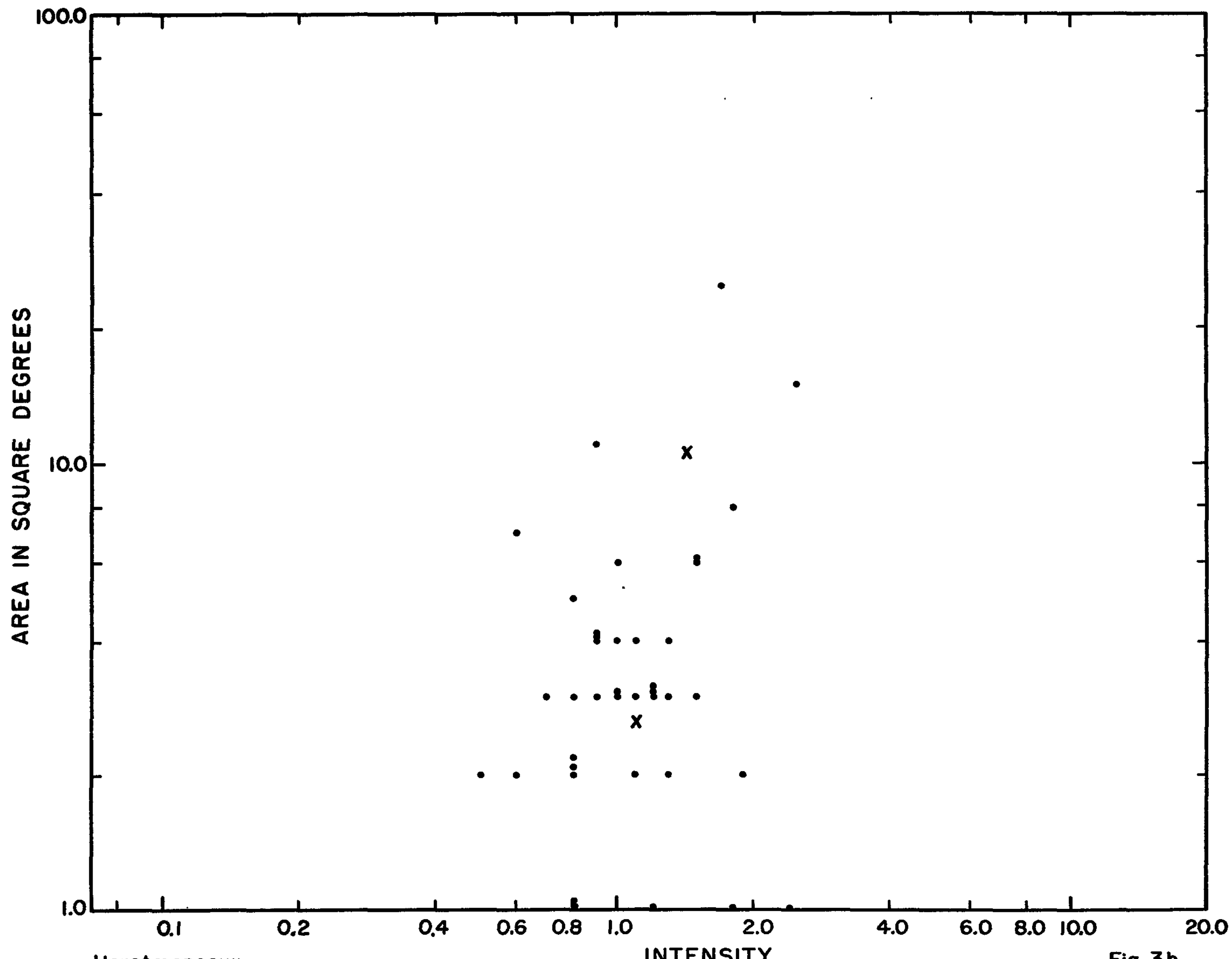
14
A
12
10
8
WIDTH
6
4
2
0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Ellison (1952)
INTENSITY
× Sept. 15, 1951
● March 24, 1951

Fig. 2d



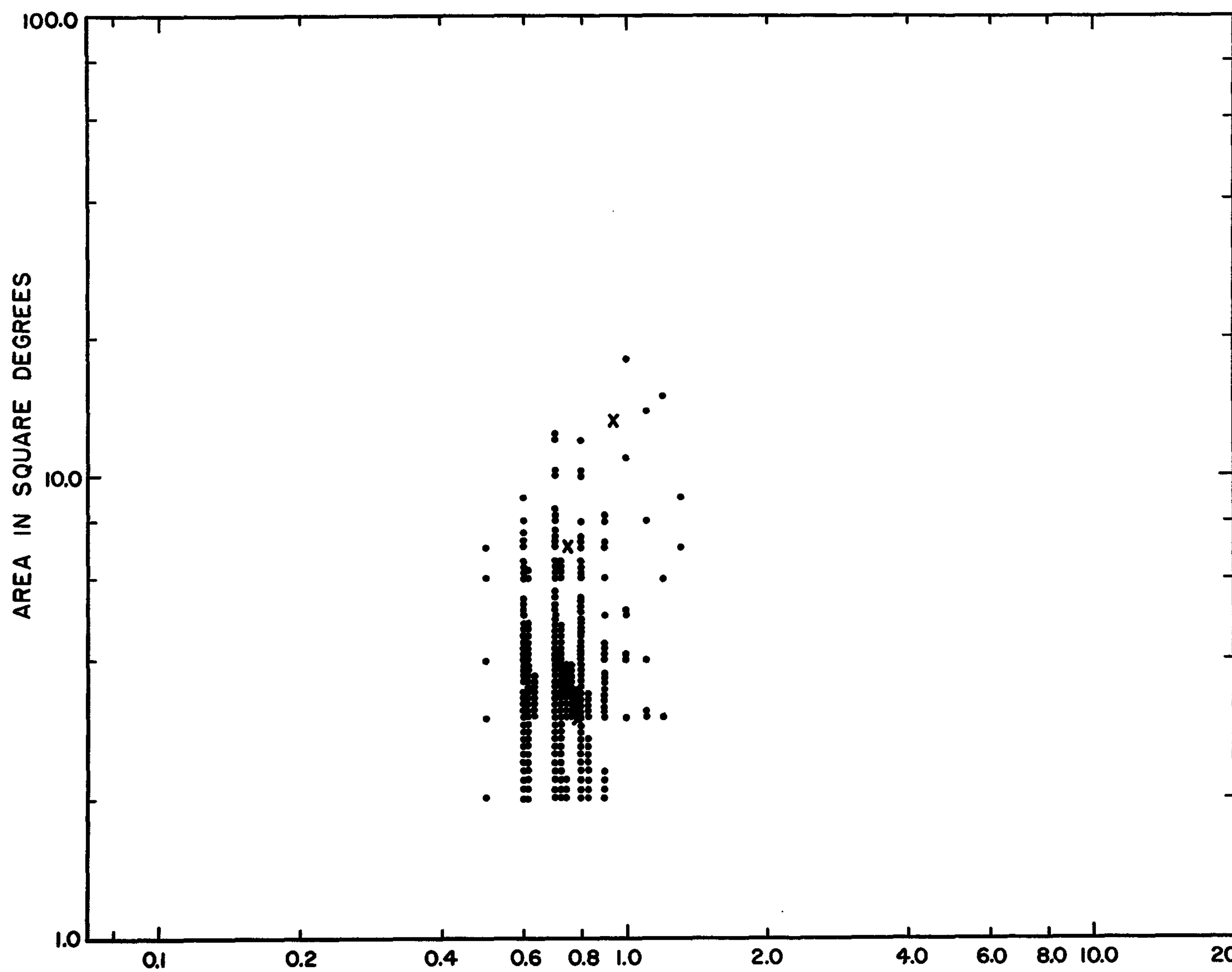
AREA IN SQUARE DEGREES
100.0
10.0
1.0
0.1
0.2
0.4
0.6
0.8
1.0
2.0
4.0
6.0
8.0
10.0
20.0
INTENSITY
IMPORTANCE
3
2
1
-1
Crimea
x = MEAN VALUES

Fig. 3a



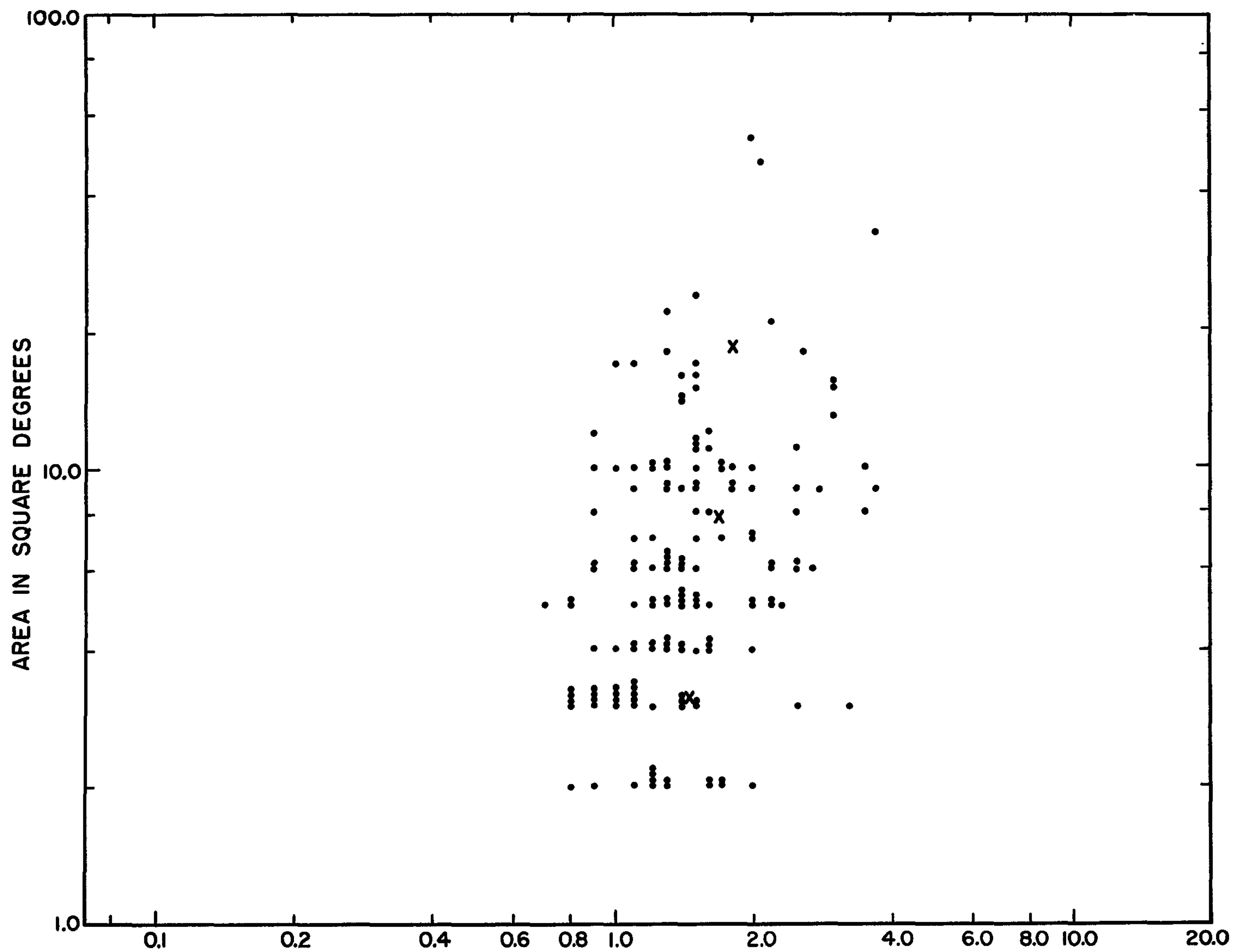
Herstmonceux

Fig. 3b



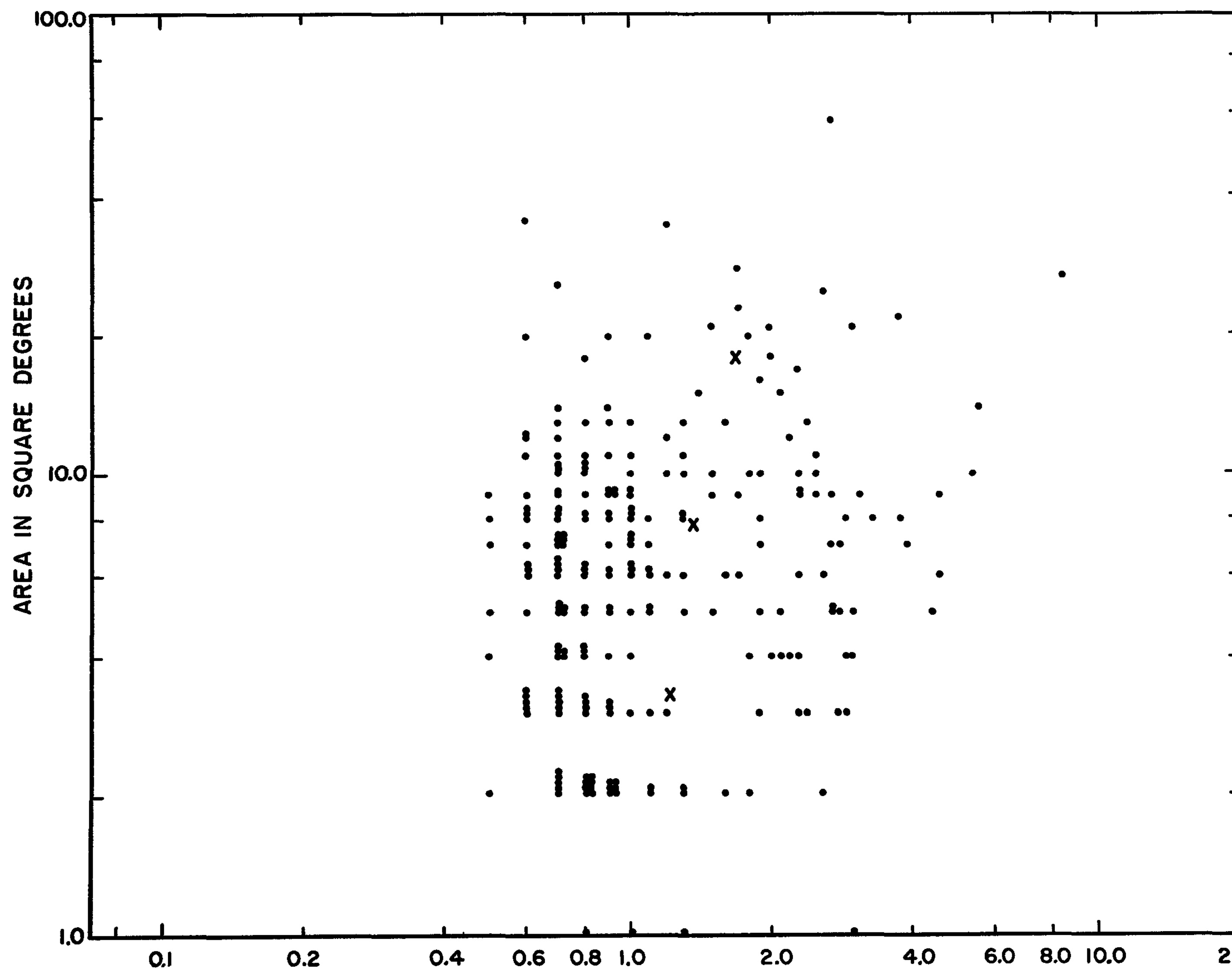
McMath-Hulbert

Fig. 3c



Moscow

Fig.3d



Tachkent

Fig. 3e

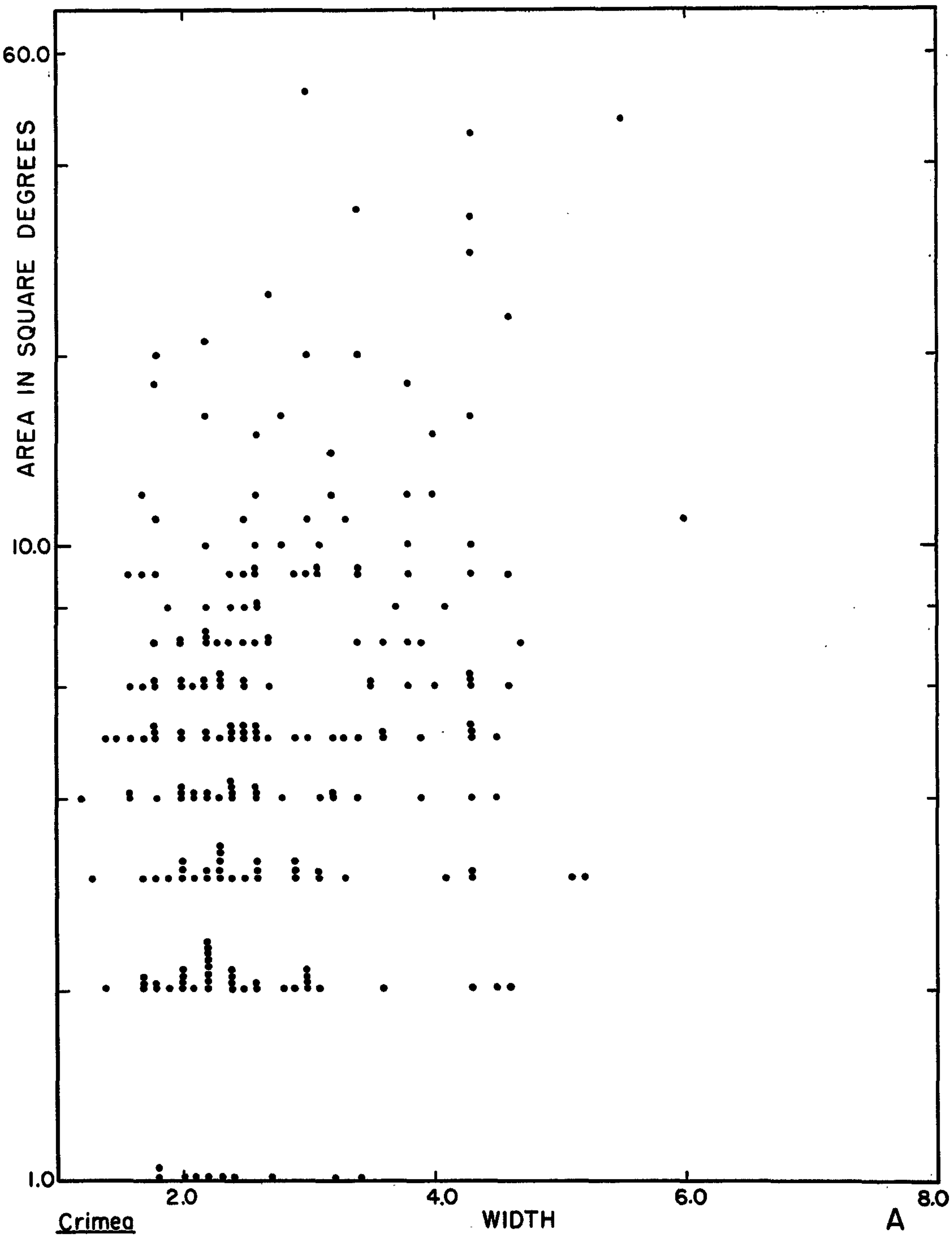


Fig. 4a

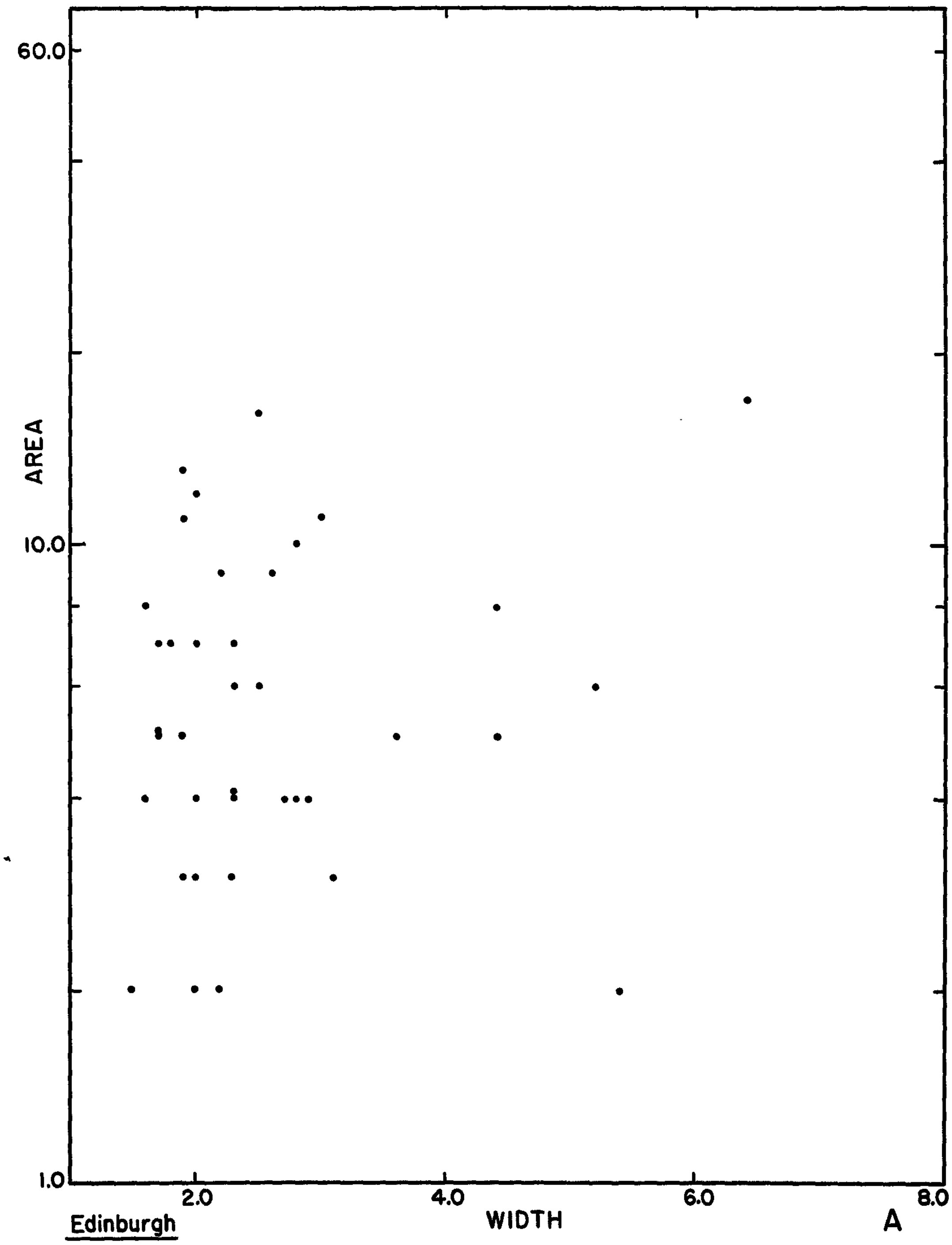


Fig.4b

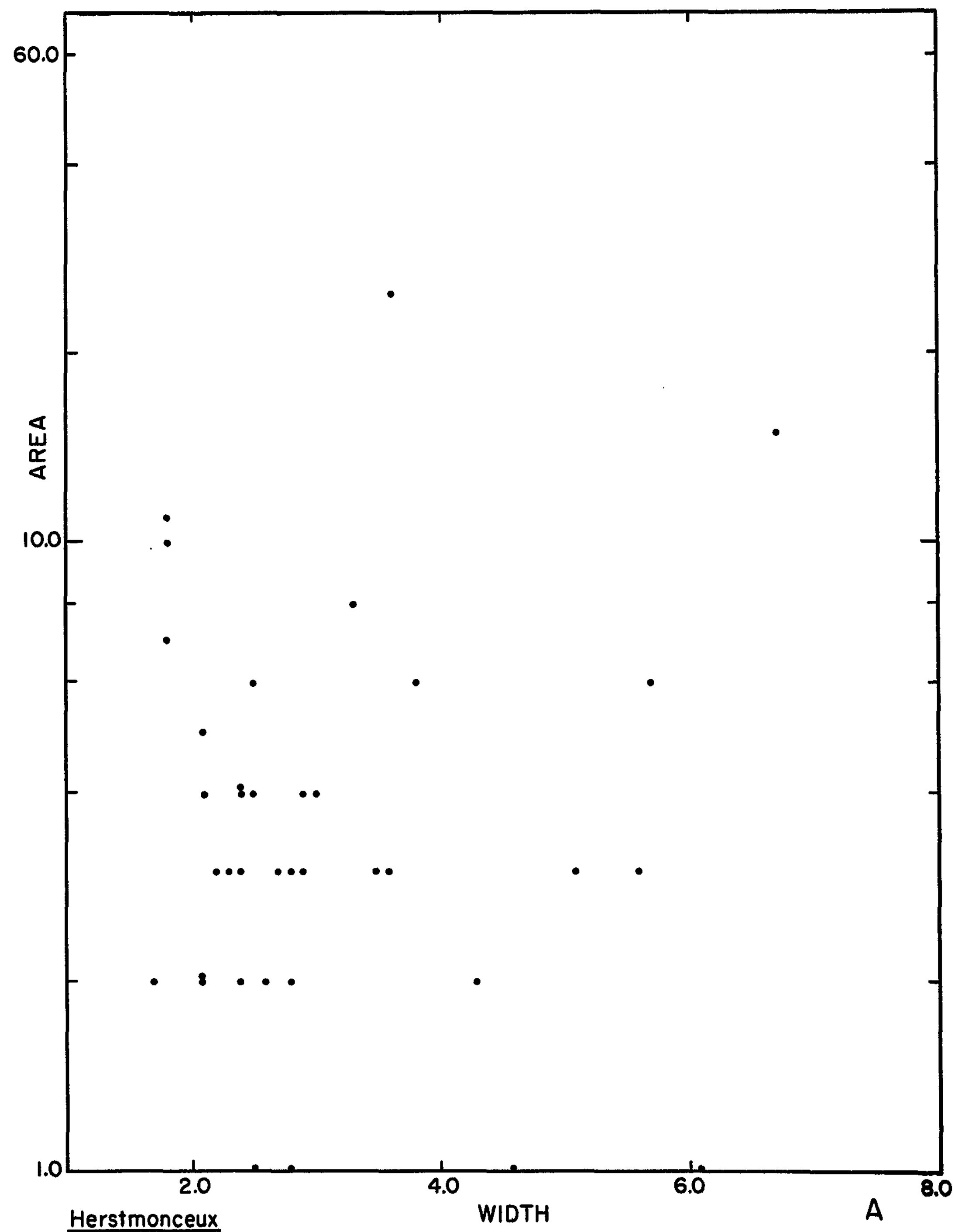


Fig.4c

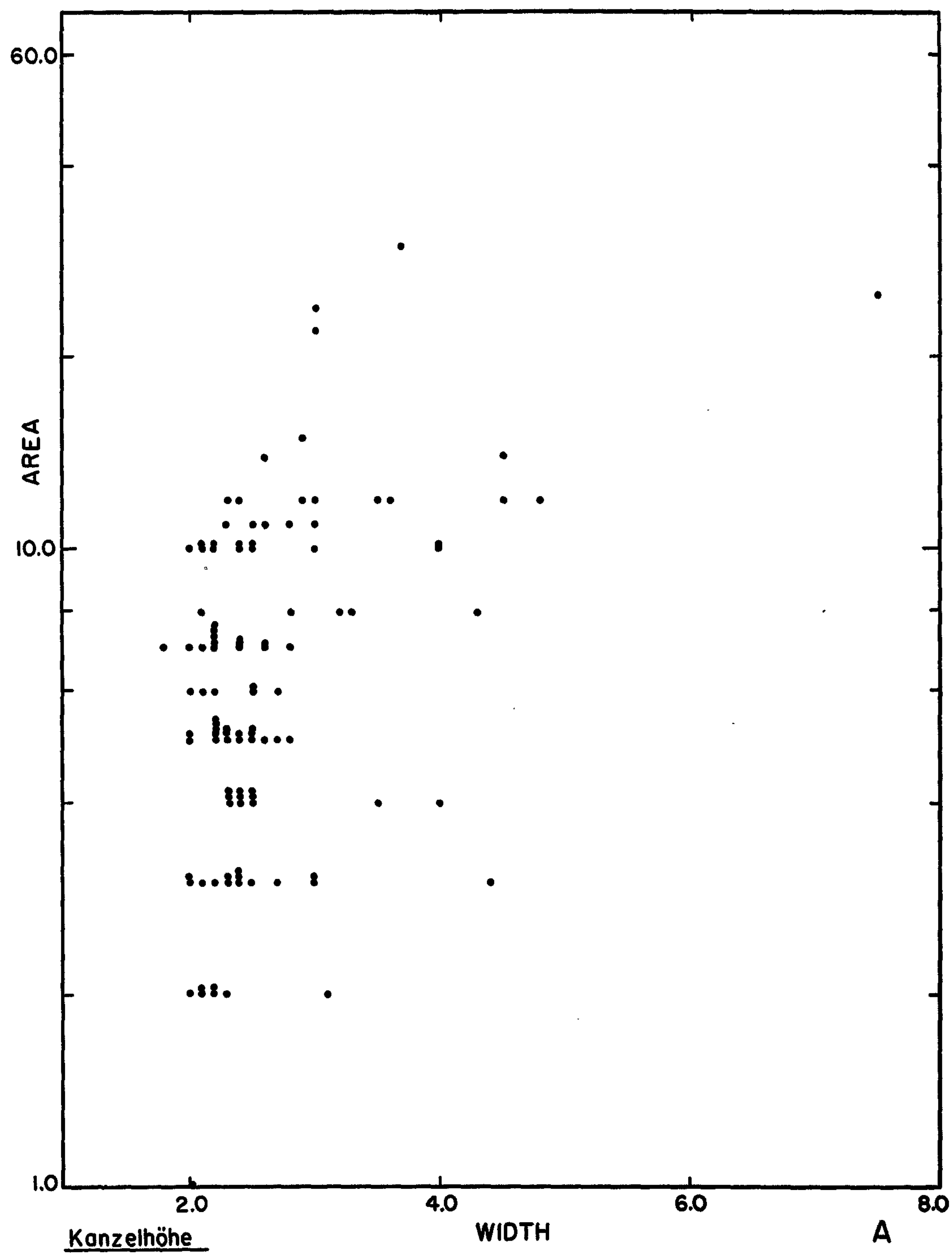


Fig.4d

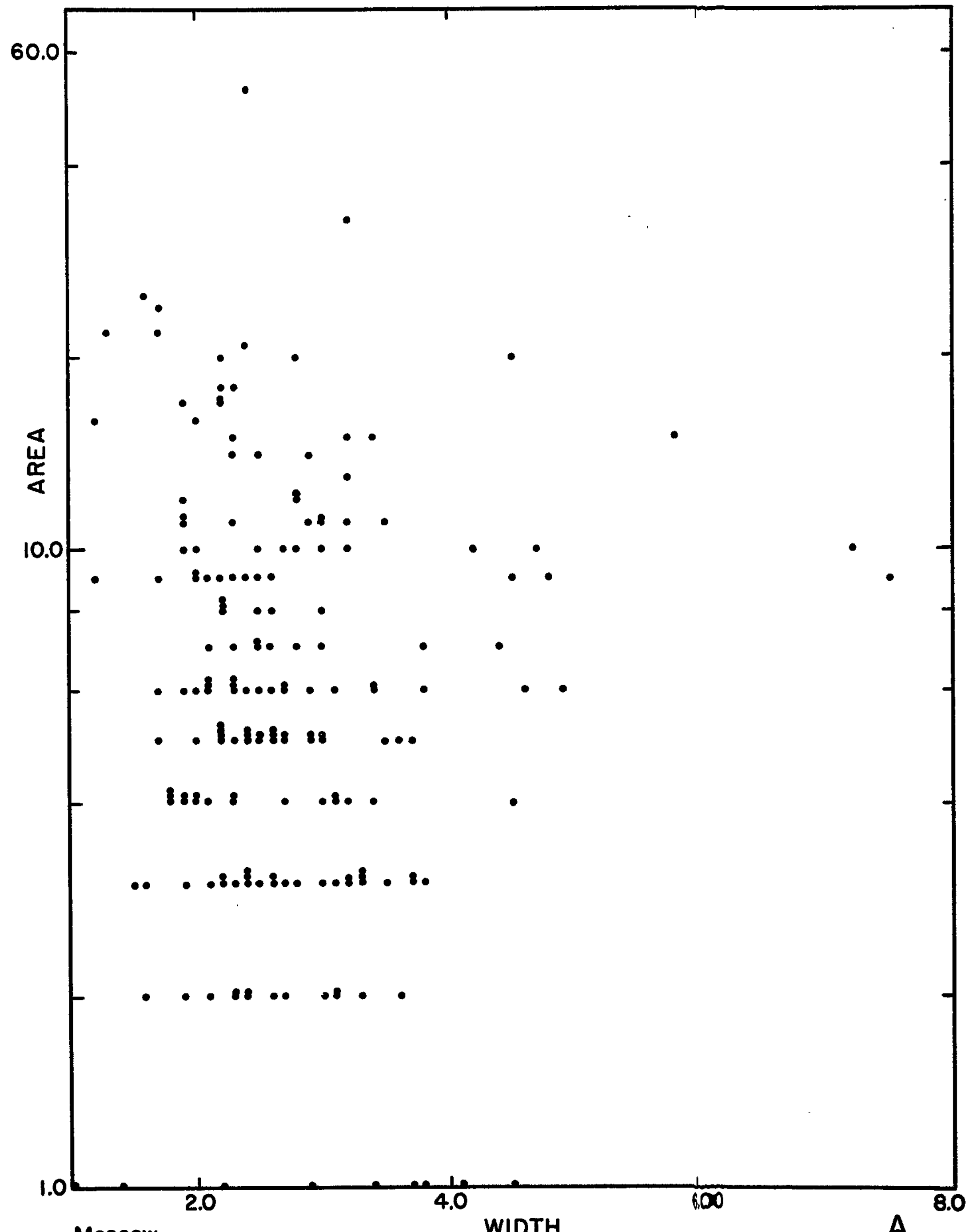
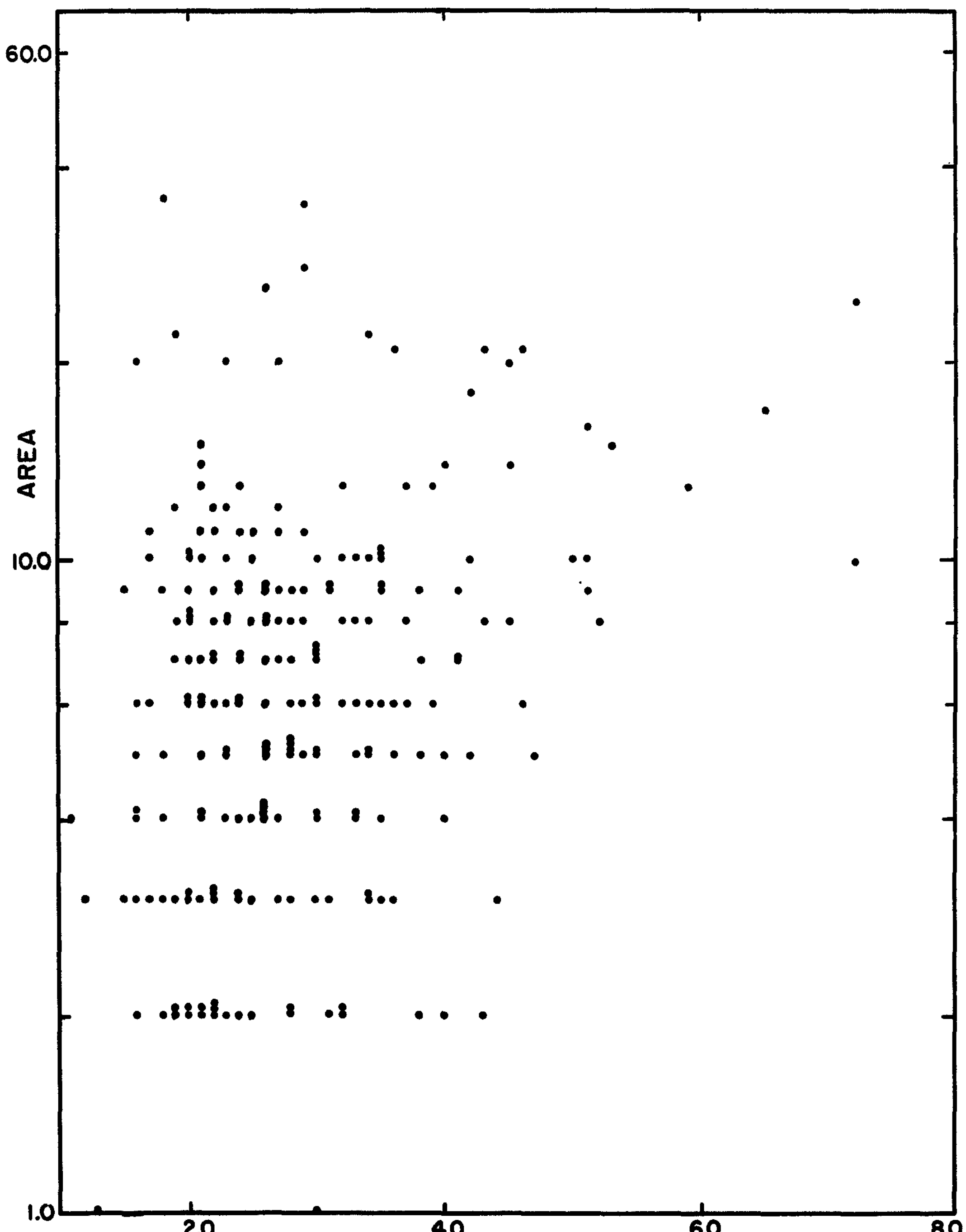


Fig. 4e



Tachkent

Fig.4f

GRD RESEARCH NOTES

No. 1. Contributions to Stratospheric Meteorology, *edited by George Ohring, Aug 1958.*

No. 2. A Bibliography of the Electrically Exploded Wire Phenomenon, *W. G. Chace, Nov 1958.*

No. 3. Venting of Hot Gases Through Temperature Inversions, *M. A. Estoque, Dec 1958.*

No. 4. Some Characteristics of Turbulence at High Altitudes, *M. A. Estoque, Dec 1958.*

No. 5. The Temperature of an Object Above the Earth's Atmosphere, *Marden H. Seavey, Mar 1959.*

No. 6. The Rotor Flow in the Lee of Mountains, *Joachim Kuettner, Jan 1959.*

No. 7. The Effect of Sampler Spacing on Basic Analyses of Concentration Data, *Duane A. Haugen, Jan 1959.*

No. 8. Natural Aerosols and Nuclear Debris Studies, Progress Report I, *P. J. Drevinsky, C. E. Junge, I. H. Blifford, Jr., M. I. Kalkstein and E. A. Martell, Sep 1958.*

No. 9. Observations on Nickel-Bearing Cosmic Dust Collected in the Stratosphere, *Herman Yagoda, Mar 1959.*

No. 10. Radioactive Aggregates in the Stratosphere, *Herman Yagoda, Mar 1959.*

No. 11. Comments on the Ephemerides and Constants for a Total Eclipse of the Sun, *R. C. Cameron and E. R. Dyer, May 1959.*

No. 12. Numerical Experiments in Forecasting Air and Soil Temperature Profiles, *D. W. Stevens, Jun 1959.*

No. 13. Some Notes on the Correlation Coefficient, *S.M. Silverman, May 1959.*

No. 14. Proceedings of Military Geodesy Seminar, December 1958, Air Force Cambridge Research Center *(U), edited by O. W. Williams, Apr 1959. (SECRET Report)*

No. 15. Proceedings of the First Annual Arctic Planning Session, November 1958, *edited by Joseph H. Hartshorn, Apr 1959.*

No. 16. Processes for the Production and Removal of Electrons and Negative Ions in Gases, *S.M. Silverman, Jun 1959.*

No. 17. The Approximate Analysis of Zero Lift Trajectories, *Charles Hoult, Aug 1959.*

No. 18. Infrared Measuring Program 1958 (IRMP 58) – Activities, Achievements, and Appraisal *(U), M.R. Nagel, Jul 1959. (SECRET Report)*

No. 19. Artificial Radioactivity from Nuclear Tests up to November 1958, *E. A. Martell, Sep 1959*

No. 20. A Preliminary Report on a Boundary Layer Numerical Experiment, *M.A. Estoque, Oct 1959.*

No. 21. Recent Advances in Contrail Suppression, *(U), S. J. Birstein, Nov 1959. (CONFIDENTIAL Report)*

No. 22. A Note Comparing One Kilometer Vertical Wind Shears Derived from Simultaneous AN/GMD-1A and AN/GMD-2 Winds Aloft Observations, *H. A. Salmela and N. Sissenwine, Oct 1959.*

No. 23. Atmospheric Refraction of Infrared Radiation, *T. P. Condron, Oct 1959.*

No. 24. Natural Aerosols and Nuclear Debris Studies, Progress Report II, *M. I. Kalkstein, P. J. Drevinsky, E. A. Martell, C. W. Chagnon, J. E. Manson, and C. E. Junge, Nov 1959.*

No. 25. Observations of Jupiter Missile Re-Entry, *(U), R. G. Walker, R. E. Ellis and R. E. Hunter, Dec 1959. (SECRET Report)*

No. 26. Space Probes and Persistence of Strong Tropopause Level Winds, *H. Salmela and N. Sissenwine, Dec 1959.*

No. 27. A Relativistic Treatment of Strong Shock Waves in a Classical Gas, *A. W. Guess, Dec 1959.*

No. 28. Measurements of Flux of Small Extraterrestrial Particles, *H. A. Cohen, Jan 1960.*

No. 29. Proceedings of the Second Annual Arctic Planning Session, October 1959, *edited by Vivian C. Bushnell, Dec 1959.*

No. 30. Atmospheric Pressure Pulse Measurements, *(U), Elisabeth F. Iliff, Jan 1960. (SECRET Report – Formerly Restricted Data)*

No. 31. A Discussion of the Calder Equation for Diffusion from a Continuous Point Source, *W. P. Elliott, May 1960.*

No. 32. Lagrangian and Eulerian Relationships in the Absence of Both Homogeneity and Time Steadiness, *M. L. Barad and D. A. Haugen, May 1960.*

No. 33. Thermal Radiation from Rocket Exhausts at Extreme Altitudes, *(U) R. G. Walker, R. E. Hunter, and J. T. Neu, Jun 1960. (SECRET Report)*

No. 34. Thermal Radiation Measurement from an Aerobee Hi Research Rocket, *R. G. Walker, and R. E. Hunter, Dec 1960.*

No. 35. Additional Note — Strong Vertical Wind Profiles and Upper-Level Maximum Wind Speeds Over Vandenberg Air Force Base, *H. A. Salmela and N. Sissenwine, May 1960.*

No. 36. Contributions to Satellite Meteorology, Vol. I., *edited by W. K. Widger, Jr., Jun 1960.* Vol. II., *edited by F. R. Valovcin, Apr 1961.*

No. 37. IRMP Participation in Operation Big Arm — Activities, Results and Appraisal *(U), Final Report, M. R. Nagel, et al, Jun 1960. (SECRET Report)*

No. 38. Examples of Project Tiros Data and Their Practical Meteorological Use, *W. K. Widger, Jr., July 1960.*

No. 39. Exploration of the Ionosphere with Telemetering Monochromators and Retarding Potential Analyzers, *H. E. Hinteregger, Aug 1960.*

No. 40. Proceedings of the Second Annual AFCRC Seminar on Military Geodesy, *edited by T. E. Wirtanen, (SECRET Report) Nov 1960.*

No. 41. Tangential Velocity Measurements – An Independent Approach to Geodesy, *B. C. Murray and N. H. Dieter, Sep 1960.*

No. 42. Topographic Charts at One-Degree Intersections for the Entire Earth, *L. Berkofsky and E. A. Bertoni, Sep 1960.*

No. 43. Cosmic-Ray Monitoring of the Manned Stratolab Balloon Flights, *Herman Yagoda, Sep 1960.*

No. 44. Methods for the Evaluation of the Green's Function Arising in the Linear Barotropic Numerical Weather Prediction Theory, *L. Berkofsky, Nov 1960.*

No. 45. Observation of Thor Missile Re-entry, *(U) R. Ellis, Oct 1960. (SECRET Report)*

No. 46. Background Measurements During the Infrared Measuring Program 1956 (IRMP 56) (Unclassified excerpts from the proceedings of the symposium on IRMP-56), *edited by Max R. Nagel, Nov 1960.*

No. 47. Wind Speeds from GMD-1 Ascents Computed Electronically Compared to Plotting Board Results, *H. A. Salmela, Oct 1960.*

No. 48. The Numerical Solution of Fredholm Integral Equations of the First Kind, *J. T. Jefferies and F. Q. Orrall, Nov 1960.*

No. 49. Infrared Spectra of High Altitude Missile Plumes, *(U), Lt. R. E. Hunter, Jan 1961. (SECRET Report)*

No. 50. Aids for Computing Stratospheric Moisture, *Murray Gutnick, Jan 1961.*

No. 51. Some Applications of the Method of Least Squares to Estimating the Probability of a Future Event, *I. A. Lund, Jan 1961.*

No. 52. Winds and Circulations in the Mesosphere, *T. J. Keegan, Feb 1961.*

No. 53. Gravity Observations Along the Northern Coast of Ellesmere Island, *F. A. Crowley, Feb 1961.*

No. 54. Radiation Studies from Nuclear Emulsions and Metallic Components Recovered from Polar Satellite Orbits, *H. Yagoda, Mar 1961.*

GRD RESEARCH NOTES (Continued)

No. 55. Proceedings of the Third Annual Arctic Planning Session, November 1960, *edited by G. Rigsby and V. Bushnell, April 1961.*

No. 56. Horizontal Sounding Balloon Feasibility Study *Maj. T. Spalding and S. B. Solot, May 1961.*

No. 57. Instability and Vertical Motions in the Jet Stream, *J. P. Kuettner and G. S. McLean, May 1961.*

No. 58. A Study of Sacramento Peak Flares II: Flare Areas and Importance Classifications, *(to be published).*

No. 59. A Study of Sacramento Peak Flares I: Distribution, Areas, and Growth Curves, *H. J. Smith, April 1961.*

No. 60. Hourly Rawinsondes for a Week, *A. Court and H. A. Salmela, July 1961.*

No. 61. New Vacuum Ultraviolet Emission Continua in the Rare Gases, *R. E. Huffman, W. W. Hunt, Y. Tanaka, R. L. Novak, and J. C. Larrabee, July 1961.*

No. 62. Bibliography of Lunar and Planetary Research - 1960 (With Annotations), *J. W. Salisbury and L. T. Salisbury, Jul 1961.*

No. 63. Flight Information and Experimental Results of Inflatable Falling Sphere System for Measuring Upper-Air Density, *G. A. Faucher, R. W. Procunier and C. N. Stark, Aug 61.*

No. 64. Maximum Winds and Missile Responses, *H. A. Salmela and A. Court, Aug 61.*

No. 65. Meteorological Evaluation and Application of Rainfall Radioactivity Data, *Per B. Storebø, Aug 1961.*

No. 66. The Formation of Ions in the Upper Atmosphere, *R. E. Huffman, (to be published).*

No. 67. Studies in Lunar Topography, *Zdenek Kopal, (to be published).*

No. 68. An Example of Chromospheric Striation Obscuration by a Great Flare, *H. J. Smith and W. D. Booton, Aug 61.*

No. 69. A Numerical Method for Computing Radiative Temperature Changes Near the Earth's Surface, *W. P. Elliott and D. W. Stevens, Sep 61.*

No. 70. Location of a Lunar Base, *J. W. Salisbury and C. F. Campen, Jr., (to be published).*

No. 71. Micrometeorite Collection from a Recoverable Sounding Rocket, *R. K. Soberman, et al, (to be published).*

No. 72. Micrometeorite Measurements from the Midas II, (1960 Zeta 1) Satellite, *R. K. Soberman and L. Della Lucca, Nov 61.*

AD

Geophysics Research Directorate
AF Cambridge Research Laboratories (OAR)
L. G. Hanscom Field, Bedford, Mass.

RELATIONSHIPS BETWEEN H-ALPHA LINE WIDTH, INTENSITY, AND FLARE AREA, by Elske v. P. Smith, January 1962. 22pp. incl. illus. (GRD Research Notes No. 74; AFCRL-62-226) Unclassified Report

The relationship between several parameters of the H-alpha line at or near maximum is studied. These parameters are line width, central intensity and flare area. The data were obtained from the I. A. U. Quarterly Bulletin. The correlations between any two of the three characteristics are quite loose, with large amounts of scatter as shown in the illustrations.

UNCLASSIFIED

1. Solar Flares
2. Astronomy

I. Smith, Elske v. P.

UNCLASSIFIED

AD

Geophysics Research Directorate
AF Cambridge Research Laboratories (OAR)
L. G. Hanscom Field, Bedford, Mass.

RELATIONSHIPS BETWEEN H-ALPHA LINE WIDTH, INTENSITY, AND FLARE AREA, by Elske v. P. Smith, January 1962. 22pp. incl. illus. (GRD Research Notes No. 74; AFCRL-62-226) Unclassified Report

The relationship between several parameters of the H-alpha line at or near maximum is studied. These parameters are linewidth, central intensity, and flare area. The data were obtained from the I. A. U. Quarterly Bulletin. The correlations between any two of the three characteristics are quite loose, with large amounts of scatter as shown in the illustrations.

UNCLASSIFIED

1. Solar Flares
2. Astronomy

I. Smith, Elske v. P.

UNCLASSIFIED

AD

Geophysics Research Directorate
AF Cambridge Research Laboratories (OAR)
L. G. Hanscom Field, Bedford, Mass.

RELATIONSHIPS BETWEEN H-ALPHA LINE WIDTH, INTENSITY, AND FLARE AREA, by Elske v. P. Smith, January 1962. 22pp. incl. illus. (GRD Research Notes No. 74; AFCRL-62-226) Unclassified Report

The relationship between several parameters of the H-alpha line at or near maximum is studied. These parameters are line width, central intensity and flare area. The data were obtained from the I. A. U. Quarterly Bulletin. The correlations between any two of the three characteristics are quite loose, with large amounts of scatter as shown in the illustrations.

UNCLASSIFIED

1. Solar Flares
2. Astronomy

I. Smith, Elske v. P.

UNCLASSIFIED

AD

Geophysics Research Directorate
AF Cambridge Research Laboratories (OAR)
L. G. Hanscom Field, Bedford, Mass.

RELATIONSHIPS BETWEEN H-ALPHA LINE WIDTH, INTENSITY, AND FLARE AREA, by Elske v. P. Smith, January 1962. 22pp. incl. illus. (GRD Research Notes No. 74; AFCRL-62-226) Unclassified Report

The relationship between several parameters of the H-alpha line at or near maximum is studied. These parameters are linewidth, central intensity, and flare area. The data were obtained from the I. A. U. Quarterly Bulletin. The correlations between any two of the three characteristics are quite loose, with large amounts of scatter as shown in the illustrations.

UNCLASSIFIED

1. Solar Flares
2. Astronomy

I. Smith, Elske v. P.

UNCLASSIFIED